Comment on Estimation of Moisture Variations in Paper Machines

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Letters

Comment on "Estimation of Moisture Variations on Paper Machines"

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To gain the maximum benefit from the application of advanced monitoring and control technologies, process insight is indispensable. An example of this is the estimation of moisture variations on paper machines.[1]

In the exponential multiple scan trending algorithm

$$\bar{Y}(m) = \frac{1}{N}\sum_{n=1}^{N} D^n(m) \tag{1}$$

$$s^n(m) = \rho(D^n(m) - \bar{Y}(m)) + (1-\rho)s^n(m-1) \tag{2}$$

the sample time at each cross-machine position will alternate between two different values, and no two cross-machine positions will have the same sample time. In the above paper[1] actual results are shown from two different paper machines using moisture scanners from different manufactures. It appears one of these, Devron-Hercules Inc., was aware of the changing sample interval for a fixed cross-machine position and hence only updated the raw profile after traversing the paper sheet twice.

Lindeborg's model, used in the above paper,[1] assumes that the sample time is the same and constant for each cross machine position. Considering Fig. 1,[1] the first cross-directional point, i.e., the point at the edge of the paper sheet, alternates between sample times of zero and twice the scan time, t_s. With N cross-directional measurement points, the sampling time at the second cross-directional point alternates between $2t_s/N$ and $2t_s(1-1/N)$. In general, the sampling time at the nth cross directional point alternates between the sampling times

$$2t_s\frac{n}{N} \quad \text{and} \quad 2t_s(1-\frac{n}{N}). \tag{3}$$

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[1] G.A. Dumont, I.M. Jonsson, M.S. Davies, F.T. Ordubadi, Y. Fu, K. Natarajan, C. Lindeborg, and E.M. Heaven, *IEEE Trans. Contr. Syst. Tech.*, vol. 1, pp. 101-113, 1993.

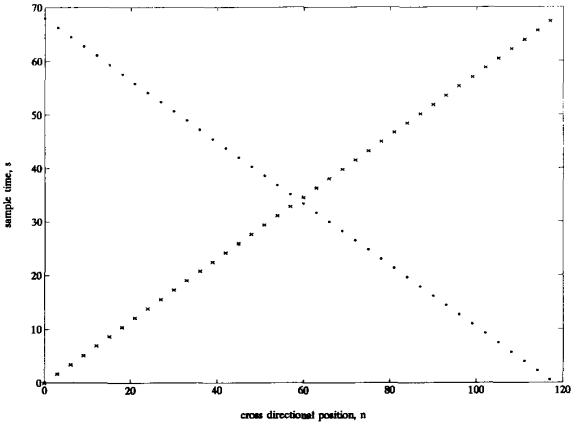

Fig. 1. Sampling time when scanning from left to right (x) and from right to left (*) for the pulp machine of [1].

Fig. 1 indicates how the sample times for the pulp machine change with cross directional point and scan direction. For the pulp machine, $t_s = 34$s and $N = 118$. The difference between the sample times has a maximum at the sheet edges, hence one would expect the largest errors in the moisture estimates at the sheet edges. The alternating sample times should generate a spike in the autocorrelation residuals around lag $2N$. Such a spike is actually seen in the autocorrelation of the residuals for the pulp machine in Fig. 11.[1] For this test $N = 118$, and the spike appears around lag 240 ($\approx 2N$).

The alternating sample time at each cross-machine position should give worse moisture estimates during machine direction upsets, e.g., changes in production speed. This is actually shown in the tests on the newsprint machine where large moisture swings with a period corresponding to $2N$ times the period it takes the scanner to move from one cross machine position to the next are noted. Also in Fig. 18, [1] there seems to be a spike at a lag of about 782, corresponding to $2N$.

These observations indicate that the moisture estimates could be further improved by using a model with $2N$ "positions." This probably is especially true for estimation of the parameter B in (15).[1] The observed negative values of B could be caused by the alternating sample times.